PROJECT FACT SHEET

CONTRACT TITLE: Geoscience Research - Imaging Technology

ID NUMBER: 97-A01 Task 03

B & R CODE: AC1005000

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CONTRACT PERFORMANCE PERIOD:
11/01/1996 to 10/31/1997

PROGRAM: Supporting Research
RESEARCH AREA: Rsvr Characterization

FUNDING ($1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	0	0	0
FISCAL YR 1997	398	0	398
FUTURE FUNDS	80	0	80
TOTAL EST'D FUNDS	478	0	478

OBJECTIVE: Advancing the understanding of fundamental processes involved in oil recovery by developing, applying and refining cross-cutting imaging techniques and technologies and improving the accuracy of prediction of oil reservoir performance.

METRICS/PERFORMANCE:
Products developed: Improved method for saturating heterogeneous, low permeability samples. Improved porosity technique using low field MR. Improved method for computing porosity using high field MR microscopy of pores. Improvement in MR microscopy image resolution (from 35 microns to 25 microns).

PROJECT DESCRIPTION:

Background: Oil entrapment and injected fluid fingering are important factors affecting sweep and displacement efficiency of oil recovery processes. Both are related to rock heterogeneity at various scales. To incorporate the effect of small scale (mm-cm) heterogeneities into reservoir models would require performing simulation using more grid blocks than it is practical or even possible with the existing computers. Therefore, the use of appropriate upscaling methods is necessary. The present work uses X-Ray Computed Tomography (CT), automated probe minipermeametry, computer assisted petrographic image analysis (PIA) and Magnetic Resonance (MR) to characterize the rock heterogeneity and fluid flow at core scale for a ripple laminated Bartlesville sandstone sample characteristic of class 1 reservoirs. These data coupled with mathematical simulations are necessary to test improved upscaling procedures for rock and flow properties at laboratory scale, with the goal in using these procedures in improving the accuracy of prediction of oil reservoir performance. MR measurements at low field (less than 0.5 T) in a frequency range (1-10 MHz), close to that used by the MR logging tools, are very sensitive to rock/fluid interactions. Techniques based on them are of high interest for their potential to provide cost-effective quality data for new reservoirs.

Work to be performed: Perform one- and two-phase experiments and simulations. Use of experimental and simulation data for up scaling testing. Install a newer CT scanner with an increased resolution and faster scanning speed for increasing the accuracy of small-scale measurements and vertical drainage processes studies. Improve the technology in performing magnetic resonance measurements at low field. Use improvements in MR microscopy to investigate the pore size and connectivity. These data are to be used in petrophysical properties calculations based on various pore network theories.

PROJECT STATUS:

Current Work: The emphasis of the present work is to perform a detailed microscale static and dynamic characterization of the ripple laminated sandstone sample, verified by flow experiments and simulations and to use the microscale data in testing new up scaling approaches of single and two-phase rock-fluid parameters. The current experimental work involves performing CT measurements of three-dimensional distributions of porosity and fluid saturations in the sample, pressure monitoring at eighteen ports on the sample faces and fluid production monitoring at the three outlet ports during single and two phase flow displacements. Low field MR measurements are used to improve the accuracy of porosity and permeability measurements, while high field MR microscopy allows to visualize the rock pore network and the fluids distributed within. The theoretical work involves performing two- and three-dimensional simulation of the single and two phase processes at fine scale and successively coarser grids for testing upscaling techniques.

Scheduled Milestones:

Accomplishments: A new procedure has been implemented for efficient brine and oil saturation of an epoxy clad low permeability heterogeneous sample. The Bartlesville sandstone sample has been brine saturated and its three dimensional porosity distribution measured by CT. Tracer tests were performed for characterization of single phase flow in the sample for a baseline for upscaling procedures. A good agreement was achieved between experimental concentration distributions measured by CT and simulated. The first drainage of the sample has been completed and the three dimensional oil saturation distribution measured by CT. A CT monitored waterflood has been completed and fine scale simulations show very good agreement with the experimental data, both in saturation distributions and pressure distributions as a function of time. The sample has been resaturated with oil and a steady state, low rate measurement has been initiated for measurement of relative permeability. The simulations were performed on a DEC Alpha 300MHz computer, which provides a significant reduction in simulation time compared to previous available platforms.

The low field MR work generated an improvement in: 1. The determination of porosity, both in a one-phase and in two-phase fluid systems, based on the linear relationship between MR specific response and gravimetric porosity for fluid saturated porous media; 2. The pore size distribution and two-phase fluid distribution within porous rock using the distributed exponential analysis of T1 and T2 relaxation data. The high field MR work generated an improvement in: 1. Calculation of porosity values for natural porous rocks using a novel method using histograms of voxel intensity to estimate the contribution from fractionally filled voxels in high resolution MR images of brine saturated samples. 2. Pore size measurements on binarized MR image data using successive stages of erosion/dilations.